Richards, L. Adolph

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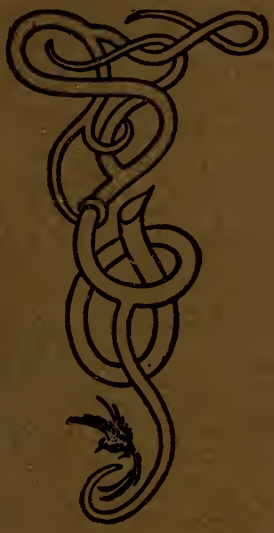

By

L. ADOLPH RICHARDS

M. A., M. S.

Comets

Of all the heavenly bodies with which astronomers have to deal, comets are among the most interesting. The appearance of these objects strikes most forcibly the attention of mortals, and their rarity, their singularity, their mysterious aspect, astonish the most indifferent minds. The phenomena which are constantly or regularly reproduced before our eyes, the things which we see every day may no longer excite either our attention or our curiosity, but in all countries and at all epochs the strange aspect of these mysterious visitors, traveling from out the depths of space, their sudden appearance and the pale gleam of their nebulous comas have produced on the minds of men the effect of a formidable power menacing the very order established at the Creation. It is the unanimous testimony of history during a period of over 2000 years, that comets were omens of impending evil and messengers of an angry Deity. They were peculiarly "Ominous of the wrath of Heaven, and as harbingers of wars and famines, of the dethronement of monarchs, and the dissolution of empires."

The appearance of some of the great comets, according to the accounts we have of such events, form one of the most imposing of all natural phenomena. We are not, therefore, surprised that feelings of awe and astonishment should be excited by the sudden and unexpected appearance of some of these objects. They have always been objects of dread to the superstitious and to the uninstructed and an enigma to those most conversant with the wonders of creation and the operations of natural causes.

The learned Greeks and the Romans, who with the other great nations have shared in this universal awe and dread, have handed down to us, often with circumstantial minuteness, the

aspects of remarkable comets. To some, these bodies were terrestrial exhalations, kindling in the region of fire, but to others, they were the spirits of great men, which were mounting to the sky, and which in leaving it, were handing over our poor planet to the plagues with which it is so often attacked. In the year 43 B. C., during the celebration of the games given by the Emperor Augustus in honor of Venus, a hairy star seen for 7 days under the Great Bear. It was very brilliant and was seen in all parts of the world. The Romans appear to have seriously believed that this comet was really the spirit of Julius Caesar on its way to join the ranks of the immortal gods. Ovid, in his great work dedicated to Augustus Caesar, concludes with this same metamorphosis. He says, "Venus descends from the ethereal vaults, invisible to all eyes, and stops in the midst of the senate. From the body of Caesar she takes his spirit, prevents it from evaporating, and bears it to the region of the stars. In rising, the goddess feels it transformed into a divine and glowing substance. She allows it to escape from her bosom. The spirit flies away beyond the Moon and becomes a brilliant star, which draws through a long space its ignited hair."

Dion Cassius says that simultaneously with the above event there was seen a burning torch and an unknown star which shown for many days. Pingre thinks that the "torch" was simply a meteor but that the "unknown star" was the same as the comet seen in China in May of the same year.

Pliny describes a comet which had a "whiteness so brilliant that one could hardly look at it." This is the same comet which Josephus describes as so horrible and which showed itself during the terrible siege of Jerusalem.

Halley's comet, which has become so famous and of which we shall speak later on, created a due amount of alarm on its appearance in the year 837. An anonymous chronicler of the time speaks of it thus:

"In the midst of the holy days of Easter, a phenomenon always fatal and of sad omen, appeared in the sky. From the time that the Emperor, who gave much attention to such phenomena, had perceived it, he gave himself no rest. 'A change

of reign and the death of a prince are announced by this sign' he said to me. He took counsel of the bishops and they advised him to pray, build churches, and found monasteries—which he did." He died three years later.

The next appearance of this comet occurred in 1066, when William the Conqueror was about to invade England. "Nova Stella, novus rex," was the proverb of the time. The chroniclers were unanimous in writing: "The Normans guided by a comet, invaded England."

While Europe was still a prey to the emotions produced by the terrible news of the capture of Constantinople by the Turks, when the church of Saint Sophia was converted into a mosque and all the Christian people were either killed or reduced to captivity; while men were trembling for the safety of Christianity, Halley's comet again makes its appearance. This most celebrated of its appearances occurred in June, 1456. The historians of the time say "it was large and terrible, its tail covered 60 degrees; it had a brilliant gold color, and presented the aspect of a waving flame. They considered it a certain sign of Divine wrath. In so great a danger, Pope Callixtus III. ordered that the bells in all the churches should be rung every day at noon, and he invited the faithful to say a prayer in order to exorcise the comet and the Turks. From this time dates the "Angelus." The custom is still kept up among all Catholic nations, although we have no longer any fear of comets and still less of Turks.

Swords of fire, bleeding crosses, flaming daggers, spears, dragons' mouths and other names of the same kind were lavished on comets in the Middle Ages and the Renaissance. The comet of 1618 A. D. inspired the following lines:

"Eight things there be a comet brings,
When it on high doth horrid range:
Wind, Famine, Plague, and Death to Kings,
War, Earthquakes, Floods, and Direful Change."

White, in his "History of the Doctrine of Comets," says these lines were to be taught in all seriousness to peasants and

school children. Milton, in his great epic poem, makes several allusions to comets and in so doing expresses the ideas and sentiments which in his time were associated with those objects. In describing the hostile meeting between Satan and Death before the Gates of Hell, he says:

"On the other side,
Incensed with indignation, Satan stood
Unterrified, and like a comet burned,
That fires the length of Ophiuchus huge
In the arctic sky, and from his horrid hair
Shakes pestilence and war."

—II-706-11.

Again, when the Cherubim descends to take possession of the Garden, prior to the removal of Adam and Eve:

"High in front advanced,
The brandished sword of God before them blazed,
Fierce as a comet; which with torrid heat,
And vapour as the Lybian air adust
Began to parch that temperate clime."

—XII-632-36.

The comet of 1528 must have struck terror to the hearts of the beholders. The celebrated surgeon, Ambrose Pare, one of the most learned men of that time, in a chapter on "Celestial Monsters" thus describes it:

"This comet was so horrible, so frightful and it produced such great terror in the vulgar, that some died of fear and others fell sick. It appeared to be of excessive length and was the color of blood. At the summit of it was seen the figure of a bent arm, holding in its hand a great sword, as if about to strike. At the end of the point there were three stars. On both sides of the rays of this comet were seen a great number of axes, knives, blood-colored swords, among which were a great number of hideous human faces, with beards and bristling hair."

The famous comet of 1680 deeply impressed all men—Jews, Turks, Catholics and Protestants were afraid. Even the learned Bernonilli himself says, in speaking of this comet, "If the body

of the comet is not a visible sign of the wrath of God, the tail might well be one."

Coming down to a more recent date, we find that as late as 1892 considerable fright was manifest when it was supposed that Biela's comet was about to strike the earth. The following dispatch from Atlanta, Georgia, was printed in one of the daily papers: "The fear which took possession of many citizens has not yet abated. The general expectation hereabouts was that the comet would be heard from on Saturday night. As a result, the confessionals of the two Catholic churches here were crowded yesterday evening. As the night advanced there were many who insisted that they could detect a change in the atmosphere. The air they said, was stifling. It was wonderful to see how many persons gathered from different sections of the city around the newspaper offices with substantially the same statement. As a consequence, many families of the better class kept watch all night, in order that if the worst came they might be awake to meet it. The orgies around the colored churches would be laughable, were it not for the seriousness with which the worshipers take the matter. To-night (Saturday) they are all full, and sermons suited to the terrible occasion are being delivered."

So much for the fear and dread which the comets have caused in all times and among all peoples. We may now ask, what constitutes these bodies which have struck terror to so many hearts. Up to the time of Newton, the nature of these objects was entirely unknown. And we must confess that even at the present date we are not entirely and completely decided on the structure of comets. The absolutely imperceptible effect produced by comets upon the motions of planets or other bodies approached by them, show that, whatever may be the matter of which they consist, it must be extremely rare and feebly condensed. Comets have passed nearer the Earth than a quarter of the distance of Venus from our planet and yet we have not perceived the least effect produced by them. Comets are so transparent that stars have been seen shining through their central parts without suffering any diminution of light, nor any refraction manifested by the slightest alteration in the apparent

place of the observed stars. Sir John Herchel describes their texture, therefore, as "almost spiritual." We must not conclude from this that the comet is an "airy nothing." As we have said before, we have not been able to detect any action whatever produced by a comet on the Earth or any other body of the planetary system. Yet they have frequently come so near the Earth and other planets that their own orbits have been entirely transformed and, if their masses had been as much as $\frac{1}{100,000}$ of the Earth's, they would have produced very appreciable effects upon the motions of the planets which disturbed them. But a body weighing only one-millionth as much as the Earth would contain 6,000 millions of millions of tons. Therefore, we must not hastily conclude that, because the comet is so extremely rare and feebly condensed it possesses no material substance.

We shall see further on that the tail of the comet is its bulkiest part but in many of the comets the head is enormous. The head of the great comet of 1843 was about 30,000 miles in diameter. The head of the comet of 1811 was very great. Schroter says that the nucleus of this comet alone had a diameter of 2600 miles and that the nucleus of the 1843 comet was still greater.

If the comet be a material substance to which the law of gravitation applies then it must move in a conic-section and having the Sun in one focus, the radius vector must sweep out equal areas in equal times. Now, Newton examined the large comet of 1680 and found that it acted in just this way. From this time on comets have been regarded as members, at least temporarily, of our solar system.

The most reasonable theory it would seem is that the nucleus of the comet is composed of a mixture of gaseous matter and of numerous small solid particles, dust particles or meteoric fragments it may be, and these, when exposed to the Sun's heat, throw off luminous nebulous particles that are swept by some repulsive force into space and form the appendage known as the tail. If we accept this theory, we must, however, remember that the particles must be very small and widely sep-

arated from each other. However, the size of the solid bodies is largely a matter of conjecture. Some think they are like grains of sand and others liken them to paving-stones or brick-bats. The nucleus is supposed to be the densest portion of this swarm of bodies and the nuclei of some large comets may be small solid bodies of great density. That portions of the solid matter become liquid temporarily, when a comet like that of 1882 dashes through the Sun's corona, is almost inevitable. The comet of 1843, which approached within 32,000 miles of the Sun, was exposed to a heat sufficient to volatilize the most infusible substances known to exist. Sir Isaac Newton calculated the comet of his time to be two thousand times hotter than red-hot iron; but this calculation was made on the supposition that the Sun was afire and the comet as dense as the Earth. But neither of these suppositions is true. The Sun is not fire and comets, as we have shown before, are not so dense as the Earth.

We see the comet only when it is in that small part of its orbit nearest the Sun and all this time, the Sun's heat is evaporating it and probably producing chemical and electrical effects. Here Spectrum Analysis, which has shown its usefulness in so many ways, lends us its aid. Until this analysis was introduced, nothing was known as regards the actual composition of comets, except the fact that their light showed traces of polarization which proved that part at least of it was reflected sunlight. The first application of the spectroscope to the study of comets was made in 1864 by Donati, the discoverer of the magnificent comet of 1858. He obtained a spectrum of three bright bands which were wider than the ordinary lines. He was not, however, able to identify them. Four years later Sir William Huggins obtained a similar spectrum and identified it with that of a compound of carbon and hydrogen. Nearly every comet which has been examined since then has shown the bright bands in the spectrum. This indicates the same or some other hydro-carbon, but in a few cases other substances have also been detected. We see, therefore, that a comet is, in part, at least, self-luminous, and some of the light which we receive from it is that of a glow-

ing gas. It also shines to a considerable extent by a reflected sunlight as there is nearly always a continuous spectrum, and in a few cases—first in 1881—the spectrum has been distinct enough to show Fraunhofer lines crossing it. But the continuous spectrum seems also to be due in part to solid or liquid matter in the comet itself, which is hot enough to be self-luminous. Again, those comets which have approached the Sun more closely than others have exhibited in their spectra, when near him, other lines, known to be produced by some metals when in a state of vapour.

Now, as to the tails of the comets. This train of tenuous matter, streaming from the head is, to the naked eye, the chief glory of a large comet. The tail is by far the bulkiest part of a comet and the tail of the great comet of 1680 was found, by Newton, to have been, when longest, not less than 123,000,000 miles in length. Prof. Pierce says the comet of 1843, about three weeks after its perihelion passage, had a tail of over 200,000,000 miles in length but later determinations give its length as 108,000,000 miles. The comets of 1769 and 1618 also had very long tails. The tail of the former extended to a distance of 97 degrees from the head and the latter a distance of 104 degrees. The tail of a comet is usually shaped like a bent cone projecting behind the comet from the Sun and at its outer extremity is millions of miles across.

The volume of the tail of the comet of 1882 is estimated to have been 8,000 times that of the Sun. The development of these enormous tails takes place when the comet approaches the Sun.

The researches of Bessel, Norton and especially the recent investigations of the Russian astronomer Bredichin, have shown that the theory that the tail is composed of matter repelled by both the comet and the Sun, not only accounts for almost all the details of the phenomena, but that it agrees mathematically with the observed position and magnitude of the tail on different dates. Also, if the tail be formed by an outpouring of matter from the comet, which always takes place when the comet is near the Sun, the more often a comet approaches the

Sun the more we should expect it to waste away. This is given as a reason for the short-period comets being so inconspicuous. By ordinary dynamical principles, matter shot off from the head of the comet while it is revolving round the Sun would give just such a curvature to the tail as it usually possesses. Likewise the variations in curvature of the tails of different comets, and the existence of two or more different curved tails of the same comet, are thus readily explained by supposing them made of different materials, repelled from the comets head at different speeds. Of this Bredichin's theory gives a complete explanation. He divides tails of comets into three types: First, those absolutely straight in space, or nearly so, like the tail of the great comet of 1843; second, tails gently curved like the broad streamer of Donati's comet of 1858; third, short bushy tails curving sharply round from the comet's nucleus, as in Encke's comet. The origin of tails of the first type is related to ejections of hydrogen, the lightest element known, and the Sun's repulsive force is in this case 14 times stronger than his gravitative attraction. The slightly curved tails of the second type are due to hydrocarbons repelled with a force somewhat in excess of solar gravity. In producing the sharply curved tails of the third type, the Sun's repellent energy is about one-fifth of his gravity and these tails are formed from emanations of still heavier substances, principally iron and chlorine. It is not very unusual for comets to show tails of two different types at the same time. The comet of 1744 is reported to have had six tails diverging like a fan. We shall have occasion later to speak of these in connection with some of the well known comets. As we have said before, the motions of comets were not understood until the time of Newton, when to the comet of 1680, he applied his great principle of universal gravitation and showed that it moved in an elliptic orbit round the Sun.

Senaca says that Appollonius the Myndian, who was very skilful in Natural Sciences, affirmed that comets were by the Chaldeans reckoned among the planets and had their periods or courses like them. He says further that Appollonius used to say that a comet was a star or celestial body like the Sun or

Moon; but that he did not know its course, because it ranges through higher parts of the world, and then at last appears when it comes from the bottom of its course.

Diodorus Siculus tells us that the Chaldeans, by a long course of observations, were able to predict the appearance of comets. As we have no record of these predictions, we will have to accept this with much hesitation. To Senaca we must pay our greatest respects for his note which anticipated the explaining of the motions of these bodies. By an effort of philosophy superior to the notions of his age, he did not adopt the received opinions respecting comets, but says, "I don't think a comet to be a sudden fire, but one of the eternal works of Nature. A time will come when these things, which are now hid, will at last be brought to light, by length of time and the diligence of posterity. One age is not sufficient to make such great discoveries. A time will come when those that come after us will wonder that we were ignorant of things so plain," and further he says, "Somebody will demonstrate which ways comets wander, why they go so far from the rest of the celestial bodies, how big and what sort of bodies they are." Sixteen centuries rolled away before this prediction was fulfilled, but in Sir Isaac Newton all these predictions have been accurately fulfilled. To him is applicable the expression of the poet:

"He first of men, with awful wing pursued
The comet through the long elliptic curve,
As round innum'rous worlds he wound his way;
Till, to the forehead of our ev'ning sky
Returned, the blazing wonder glares anew
And o'er the trembling nations shakes dismay."

The comet of 1680, was first seen with a telescope by Gotfried Kirch, at Corbury in November. It is sometimes called Newton's comet because, as we have stated before, in reference to it he showed the applicability of the law of gravitation, and should it appear in 2255, it will probably be regarded as a memorial of Newton. Upon the principle of the law of universal gravitation, Newton calculated its orbit and found that the

comet was moving in a long elliptic orbit, requiring several centuries to traverse. Newton as well as Halley thought that it might be identical with large comets seen in A. D. 1106, A. D. 531, and B. C. 44, the one which appeared just after the death of Julius Caesar. More recent calculations, however, show that the period of the comet of 1680 is more than the interval 575 years, but it is impossible to determine this accurately from observations made at the one appearance. We have no exact observations of the comets of 43 B. C., 531 A. D. and 1106 A. D. We cannot calculate their orbits and therefore we lack the only criterion by which we could decide with certainty the identity of these comets. We do know that those of 1680 A. D., of 1106 A. D., of 531 A. D., and of 43 B. C. were very brilliant and we find that the time elapsing between these appearances is roughly 575 years.

From 1106 to 1680 we have 574 years. From 531 to 1106, we have 575 years. From 43 to 531 is 575 years.

The next remarkable comet was the famous Halley's comet, which appeared in 1682. This appearance led to the first successful prediction of a return of a comet. It was made by Dr. Halley, the contemporary of Newton. Halley's prediction was fulfilled (16 years after his death) by the comet's reappearance in 1758. Halley calculated the elements of the orbit of the comet of 1682 and applied the same methods of calculation to the observations which Kepler had made on the comet of 1607. He found that this gave results in regard to the inclination of its orbit, the place of its node, the situation of its perihelion, and the retrograde direction of its movements, so closely comparable to the first set that there was little doubt that it was the same object. Between these two periods there was an interval of 75 years. In reckoning backwards from 1607, he found that in 1531 or 1532 a similar comet had been observed and the results deduced were almost precisely the same. Going still further back, he found that a similar comet had appeared in 1456.

This was the comet which excited such great consternation in Europe, its appearance having been regarded as connected with the menacing success of the Mahomedan armies. Since

there were not sufficient observations on this comet its elements could not be determined. Also a remarkable comet recorded as having been observed in 1305 or two 75 year periods previously, and also one in 1230 were reasonably supposed to have been the same.

Having shown these identities, Halley confidently predicted that the comet would reappear in 1758 or the beginning of 1759. He realized that there was some influence at work which was causing some slight change in the comet's period and hence he left the precise time of return in some degree of uncertainty. However, he was confident in his prediction and desired that it should be remembered that its author was an Englishman.

In Halley's time, it was impossible to determine with exactness the values of these perturbations—the difficult problem which Clairant has resolved. Clairant found that by reason of the diminution which the attraction of the planets causes in its progress, the comet would employ 618 days more to return to the perihelion than in the preceding revolution. This was 100 days from the effects of Saturn and 518 days by the action of Jupiter. The passage then, should correspond with the middle of April, 1759. Clairant reserved 30 days of grace, for he said he had neglected small values in his calculations. All these predictions were fully justified, for according to expectation, the comet passed its perihelion on the 12th of March, 1759, within the assigned limitation. Halley's comet returned again in 1835 and we may expect it again in 1910.

There are many other comets which are remarkable because of some striking peculiarities or because of circumstances connected with their discoveries. Of these we can here mention only a few. We have seen that the period of revolution of a comet is usually large and in some cases it is enormous. It is therefore interesting to note that Encke's comet has the honor of being our most frequent visitor, having the shortest known time of revolution. Its period is only three years and a half. This comet has been observed at almost every return since 1819, the year in which Encke detected its periodicity. It had been observed frequently during the 50 years preceding this date.

This comet shows a very conspicuous change in diameter as it approaches and recedes from the Sun. When it is at perihelion its volume is only about $\frac{1}{10,000}$ of what it is when first seen. This comet is also remarkable in that, since its discovery in 1819, it has been continually quickening its speed and shortening its period at the rate of about two hours and a half in each revolution; as if it were under the action of some resisting medium.

We have before referred to the scare produced by the comet of 1832 when it approached so near the Earth and gave rise to the first comet scare of the century. It was discovered in 1826 by an Austrian, named Biela. It was the second of the short-period comets in order of discovery. Its period was 6.6 years. We are very much concerned about this comet because after acting very strangely on two of its returns, it became "lost" and we have never seen it since, although it should have paid us five other visits.

On its return in 1846 it showed that it had met with some mishap for it was now divided into two and when last seen the two parts were traveling quietly in their appointed orbit but separated by about 1,500,000 miles. Miss Clerke says, "It became evident that Biela's comet was shedding over us the pulverized products of its disintegration," when on the night of November 27, 1872, just as the Earth was passing the old track of the lost comet, she encountered a wonderful meteoric shower. Miss Clerke's view may be correct but it is perhaps expressed a little too positively.

Donati's comet of 1858 must be mentioned, for, although not the largest or most extraordinary, it was on the whole the finest comet of the century. The exhibition of the unrivaled perfection of the development and structure of concentric envelopes have made it the normal and typical comet. Its tail was of the second or hydro-carbon type with faint tangential streamers which belong to the first or hydrogen type. Its periodic time is nearly 2,000 years.

The great comet of 1882, which we have referred to before, will always be remembered not only for its beauty but for the

great variety of unusual phenomena which it presented. It was first seen with the naked eye at Aukland, New Zealand, on September 2, and by the 8th, it had been observed at Cordova, (South America) and at Cape of Good Hope. It was so bright that by merely shutting off the Sun with the hand, there was not the slightest difficulty in seeing it.

Swift's comet of 1892, is remarkable on account of the marvellous changes observed in its tail. On April 4th, it was 20° long, straight and slender. The next morning a new tail had formed between the other two, and each tail was composed of several lying close together. At least a dozen could be counted. After the lapse of another day, one of the original three tails had vanished, and the other two were blended. Then one of these grew bright and the other faded away; the bright one had a sharp bend in it, as if turned aside by some obstacle. Finally, the tail split up into six branches. All these changes and some others took place within five days.

We must not pass over Dr. Brooks' comet. Dr. Brooks is known in astronomical circles as the comet finder. (Smith and Barnard also share this honor.) On the 24th of the present month (May 24, 1909) he has just discovered at the Smith Observatory, Geneva, N. Y., an object which he thus describes: "The object was visible in the eastern sky from 2 to 3 o'clock this morning. It had the appearance of a gigantic 'naked-eye' comet, with a large head and a tail of enormous proportions. When first seen the head was in the great square of Pegasus and the tail stretched upward toward the north star, at one time reaching the chair of Cassiopeia. The motion was rapidly eastward. At 2.30 a. m. the head enveloped the star Algenib, and by 3 o'clock it had reached the horizon. Soon afterward the tail was lost in the rapidly advancing dawn." This is the twenty-sixth comet discovered by him, fifteen of these having been discovered at the Smith Observatory during the last sixteen years. The other eleven were discovered at the Redhouse Observatory, Phelps, N. Y. The comet which bears Brook's name is the one discovered on the morning of October 17, 1892. A photograph taken by Dr. E. E. Barnard on the morning of October

21, showed remarkable changes in the tail which Dr. Barnard thus describes:

"It presented the comet's tail as no comet's tail was ever seen before: The graceful symmetry was destroyed: the tail was shattered. It was bent, distorted, and deflected, while the larger part of it was broken up into knots and masses of nebulosity, the whole appearance giving the idea of a torch flickering and streaming irregularly in the wind. The short northern tail was swept entirely away, and the comet itself was much brighter. The very appearance at once suggested an explanation which is probably the true one. If the comet's tail, in its flight through space, had suddenly encountered a resisting medium which had passed through the tail near the middle, we should have precisely the appearance presented by the comet. It is not necessary that the medium should be a solid body; if it possessed only the feeblest of ethereal lightness it would deflect, distort and shatter the tail. What makes this explanation all the more probable is that the disturbance was produced from the side of the tail that was advancing through space."

Within less than a month after the discovery of the comet mentioned above, Mr. Holmes, an English amateur astronomer, on November 6, 1892, discovered a comet which has his name. This comet was supposed, by some, to be the lost Biela's comet, since it occupied about the same position in the sky as Biela's should occupy, if still in existence, and the latter was due at this time. It is peculiar in that its orbit is more nearly circular than that of any other known comet. Its period is less than seven years.

The little comet which was seen in Egypt on May 16th, 1882, was distant from the Sun about the amount of the Sun's diameter. It was seen with the naked eye during the eclipse of the Sun. It was of course seen for a few moments only and it has never again been seen. It is chiefly interesting in that its existence was recorded on several of Dr. Lockyer's photograph plates while he was photographing the eclipse. During the total eclipse which occurred on April 16, 1893, another comet was photographed in the corona. This comet was very much

fainter and more difficult to recognize than the one photographed in 1882. Some think the two comets may be identical, with a period of about 11 years.

We have here spoken of only those comets which from their associations, their size, or other distinguishing characteristics, have been rendered somewhat more remarkable than their numerous associates. In this limited space it would be impossible to give accounts of all the comets which have been carefully observed and their orbits and periods determined. Including the returns of the periodic comets, there are now on the lists about 700. There is seldom a day when at least one comet is not in sight and to this number are added as high as 4 or 5 each year.

We have found that neither fear nor dread need be apprehended from their visits. "They come to please and instruct, not to injure or destroy." There are authentic astronomical records which relate to a point of time four thousand years back and ancient zodiacs, hieroglyphics and astronomical fables, referring to a yet more remote period. Still we have no account of comets ever doing any mischief. They have become our best teachers in that they never fail to hold our attention and to awaken in us the desire to know more about the lessons we may derive from them. They are welcome visitors and we hail with delight not only their first visit but also the return of the periodic comets.

NOTE: The astronomers of the world are preparing to welcome back from the regions of space, a comet which for more than seventy years has been out of mortal sight. For thirty-eight years it traveled away from the Sun at the rate of more miles a minute than the fastest railroad train can make in a whole day and went so far that it was a half million miles beyond Neptune, and Neptune is at the edge of our solar system, more than 3,000,000,000 miles away from the Sun. For more than thirty years this heavenly traveler has been coming towards us at this same tremendous speed—26 miles per second. By the middle of May, 1910, it will have approached to within 95,000,000 miles of us. Then it will turn back once more, and speed away on its 76 years journey through space.

This strange visitor is none other than the famous Halley's comet to which we have alluded several times before in this brief treatise.